Kinetic Energy

An Honors Thesis (Honors 499)

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Abstract

In the academic culture, science and art are often viewed as wholly separate intellectual spheres. When the two disciplines are juxtaposed, however, a researcher may have the ability to understand each discipline, and the relationship between the two disciplines, more deeply. Science has the potential to provide inspiration for art, and art has the ability to explain science. In the dance performance concert *Kinetic Energy*, scientific concepts such as the research process, the Ideal Gas Law, magnetic fields, waves, the Universe, and the physiology of the human heart, are expressed through dance. The purpose of this expression was to provide the dance community with exposure to scientific concepts and to provide the scientific community with an opportunity to broaden their creativity and viewpoint of concepts they may have previously studied.

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Authors' Statement

The choreographers began with the goal to create a dance concert that would demonstrate the potential for collaboration between the arts and sciences. To demonstrate this collaboration, both choreographers took inspiration from past studies and experiences in the sciences to create dances. For example, Hannah Smalley chose to portray the concept of the physiology of the human heart because of her in depth study of the organ during exercise science classes and Erika Ripley chose the Ideal Gas Law after her study of physics. The process of transferring a concrete idea to that of an abstract expression challenged the choreographers to think like scientists, while also expressing like dancers. This resulted in a broadening of each choreographer's movement vocabulary as well as a new appreciation for the potential results of collaboration, which the choreographers wished to present to an audience. The final product of their exploration was a dance showcase that highlighted the choreographers' diversity of knowledge from both science and dance. The purpose of the concert was to engage an audience both intellectually and artistically, and to empower them to see the connection between science and creativity.

The goals for this project were to expand researcher knowledge of previously studied scientific concepts through the application of science to choreography, to produce a smoothly run performance of four to six dances, to hold an active discussion after the performance that enhances the audiences' understanding of the science behind the work, and to raise at least one hundred dollars for the Muncie YWCA through ticket sales. After two performances, each of these goals was reached. Through research and choreography experimentation, both choreographers were able to learn new information regarding their own topics, and each other's topics as well. Discussions at weekly choreographers' meetings to helped refine and filter each

other's ideas, and resulted in increased scientific understanding for both choreographers, as well as a cohesive and well thought out performance, verifying that each concept, and its role within the show, was clear. Each piece within the show, *Kinetic Energy*, was used to represent the many fields within science, just as how there are many fields within dance. "Researchin'" represents the overall scientific process, "Ideal" covers both physics and chemistry, "Equal, but Opposite" showcases the concept of magnetic fields, "Propagation" is another exploration of physics, "Star Stuff" spoke about star formation as well as humanity's connection to the Universe, and finally "Open Me Up" explores the complicated anatomy and physiology that takes place within the human heart. The final concert was a smoothly run production with transitions in between each piece to increase continuity speed of transitions. Audience feedback during the discussion period suggested these transitions were successful in their goals. This discussion section provided an atmosphere of open critique and feedback for the choreographers, as well as a platform for the choreographers to provide intellectual and artistic explanations of each dance for the audience. By the end of the two performances, the project goals were met, and three hundred and twenty-five dollars were raised for the Muncie YWCA.

The creation of each dance was expanding, both as academic thinkers and artists, as it resulted from the reflection and application of laboratory class work into an artistic setting. In this way, the choreographers were able to take ideas that are considered concrete and express them in a creative manner. Engagement with the concepts that inspired the pieces, the ability to arrange the thoughts into dances, and the dances into an organized concert, demonstrated both a passion for the topics chosen as well as organizational talents in the choreographers.

As the process of producing, choreographing, and stage directing *Kinetic Energy*

progressed, a major theme developed and the choreographers chose to make various technical changes to incorporate it. This theme is connectivity. Every human is connected, or as Neil DeGrasse Tyson says, "We are all connected; To each other, biologically To the earth, chemically; To the rest of the universe atomically." This connectivity was first enacted through the association of the YWCA and the choreographers' wish to donate the proceeds from *Kinetic Energy* to them. It then became essential to transition fluidly from one piece to the next so that the show was one product, rather than six pieces strung together incoherently. This change, in which was later reflected as an important one, became a visual demonstration of the connectivity between the sciences each piece represented. The late addition of the piece "Star Stuff" accompanied by the narration from N.D. Tyson is the artistic representation of the need to be connected. Finally the ultimate hope of producing a concert with such a theme was that, through audience discussion and participation, members would leave with the expanded knowledge of the connection between seemingly opposite studies, and potentially see their own connection to both.

The Choreographic Process of "Researchin'"

By creating a show about science, it only made natural sense to choreograph a piece about the scientific process. Specifically this piece was inspired by the choreographer's close observations of her own relationship with those who consider themselves scientists. Besides inspiration, the first step in the choreographic process was to determine the tone of the piece. Through collaboration with Hannah Smalley, it was determined a piece about scientists themselves would be a good opener for the show. As far as introductions go, they should be light, quick, easy to grasp, and make you smile and therefore want more. These qualities were immediately kept in mind when first choreographing. There are also generally two stereotypes of scientists: Cold and calculating or zany and aloof. The latter was chosen to mimic the previous decision.

Finally, the most important aspect of determining the tone is in the choice of music. Imagined science scenery brought up auditory visuals of computers "beeping and booping" as well as the typing on a keyboard. In search of a song, the choreographer tried to find ones with a computer-like quality and even brought her search to music made by computer parts. Several songs were used throughout the choreographic process, usually with songs being disregarded due to harsh qualities. "Fireflies" was decided on due to its light, bubbly quality and also because the song had no real melody/refrain structure. By having no melody, it allowed the music to have a consciousness and therefore addressed the implication that this process the scientists are performing occurs all the time.

With the tone set and the decision for the piece to focus on research, the choreographer had to make the decision on what the scientists were researching. Because of the involvement of science and dance in this show, it only made sense for them to research a dance concept. The

first that came to mind was the first movement any young dancer wishes to perfect: the pirouette. With a goal in mind and the tone set, it was surprisingly easy to set movement to this piece. The quality of movement was inspired predominantly by the "chicken scratch" notes that scientists use. The sharp angles in numbers, equations, and Greek symbols led to many of the movement phrases to include straight lines and obscure angles. Raising and lowering arms at 90 degree angles initially was done to represent levers being raised and lowered. However, throughout manipulation of this motif, it became to represent the passing of knowledge between scientists. Instead of raising a lever, they are picking up an academic paper and passing it to another, representing the furthering of research. Much of the movement was also performed laterally across the stage. This was a decision made to represent the motion that occurs when walking through hallways and going in and out of doors. The scientists are thus moving about a building, rather than being in one solitary room.

The incorporation of lab coats also influenced the choreographer's movement choice as specific changes were made so that the length of the coat would flow and move behind the scientist. To fully incorporate the "scientist" image, safety goggles were choreographed into the piece, with specific moments to place them on and off. Whenever the scientist had goggles on, an experiment was in process, when they were off, the experiment was over.

The centralized moment of the piece occurred when the scientists looked into the sky. This observation was inspired purely by the science of astronomy, also known as the observational science for all we, as a society, know about the Universe is from observation. This was a significant moment in the piece as the scientists could do nothing but wait and observe. Much of this is not realized by "normal" society, the amount of time it takes to make a significant discovery. This particular moment in the piece attempts to explore that. The scientists

leaned back into each other for support, furthering the idea of community as they gazed into the sky. Finally inspiration hit and they all pointed towards the sky. It was expressed to the dancers that in this moment, an idea lies on their fingertips. They were instructed to take that idea and follow it wherever it goes, thus while each scientist had the same inspiration; it provided them with differing ideas and led them to different conclusions.

As the piece continued, the scientists slowly began to perform the same movement together, once again signaling the scientific community working together on a project. Not until the very end, did the scientists move in unison and then complete their research on the pirouette. Many think the final step in the scientific process is the conclusion. In actuality there are two additional steps that follow. The first is to repeat the findings. The second is to publish the findings so that others may read and learn from it. This is done at the end of "Researchin'." The decision was made for one scientist to perfect the pirouette and then celebrate the findings with her colleagues. She shared the information and the final moment of the piece all five scientists performed the pirouette together, signaling the information is now available for anyone. Ergo, anyone can now perform the pirouette and the dance community has expanded its knowledge and vocabulary.

By working with a group of dancers with varying personalities, the choreographer was surprised when certain characteristics began to arise throughout the process. The qualities were then assigned to the dancers and each dancer expanded on their character for the remainder of the process. This resulted in the piece possessing more expression than originally intended. The characters included the intern who doesn't know much, but is extremely happy to be there; the head researcher who only wants results; the eager research assistant, who wants to prove themselves; and another research assistant who doesn't know what's going on, keeps getting bad

results, and hangs around the other scientists instead. This also added a much needed dose of humor to the piece, which fulfilled the requirement of making an audience smile during the introduction.

The Choreographic Process of "Ideal"

The Ideal Gas Law was the piece that helped majorly inspire the show itself. The idea started more than a year ago in 2011 when the choreographer had been majoring in physics. Throughout her classes it was made apparent her mind was not in the subject and in order to challenge herself, the choreographer would devise ways to interpret the physics lecture as an expression of dance. Of the various ideas that spawned, the one concerning the Ideal Gas Law stuck, and stayed with the choreographer until she found the appropriate time to bring the idea to fruition.

What specifically made the idea remain with the choreographer for so long was the possibility of using the lighting system in Korsgaard dance studio (KDS) to its advantage. The limited lighting could be used purposefully and therefore the keen eye would not notice the studio's disadvantage. In addition to that, the choreographer had, at the time, recently viewed David Parsons' "Caught" which featured unique lighting and the choreographer wished to emulate that.

The Ideal Gas Law itself is the relationship between pressure, temperature, volume, and moles (particles) as represented by the equation PV=nRT where R is constant (8.314 joules per mole per degree Kelvin). Pressure and temperature are directly proportional to each other whereas volume is inversely proportional to pressure and temperature. It was first known that volume would be represented by the lighting in KDS. In KDS, there are nine overhead spotlights, known as specials, and three wings with lighting on each side. When designing this piece, a three by three grid was made to represent the stage. The choreographer then experimented with different lighting possibilities using the grid. Each special represented the smallest (one by one) volume, the side lights represented the medium (one by three) volume, and all the lights in

combination represented the largest (three by three) volume. Before rehearsals had begun the first six lighting cues were determined. Consequential rehearsals started with the previous knowledge of specific lighting.

Pressure was chosen to be represented by the quality of movement. Movement quality can be defined in terms of accents such as sharp and striking versus delicate and flowing. The temperature was then chosen to be represented in terms of speed. It is also a representation of energy, as a cold object possesses less energy than a hot object. Thus a human with less energy moves slowly and one with more energy moves quickly. Since pressure and temperature act directly together the manipulation sharp and quick were used together as were flowing and slow.

When creating movement for this piece, a phrase was first created. This phrase was usually created in high pressure and temperature or in low pressure and temperature, never in the middle. This phrase was then modified to fit the number of dancers (particles) and the size of the volume. The most challenging aspect of this was modifying the phrase to fit the medium temperature and pressure, and maintain the correct timing as seen in the middle of the piece where a triangle of small volumes was used. The volume with two particles had difficulty making sure their tempo was different from that of the fast and slower volumes. This method of creating a phrase, and then manipulation was used several times throughout the piece.

About midway through the process the thought to use a completely randomized method came to mind. This was due to the nature of the piece as it is a form of a chance dance. These types of dances can occur in many forms. One such form is to structure the piece with specific rules that must be followed, which is what "Ideal" is. Another, more common or obvious way to create a chance dance is by assigning movement to a number and then having dancers select numbers at random, thus selecting the order for which they perform the movement in. This

method was first used during the first large volume section. However, during the next rehearsal the process, while at first intriguing, had to be cut and the choreographer returned to the previous process mentioned above.

The decision to include scientists in the piece came about from a discussion with Hannah Smalley and the advisors for this project. There was a need to add purpose to the particles entering and exiting the volumes and while the scientists initially set up the piece, the inclusion of them throughout was a wise decision. The addition of the scientists into the piece was quite simple as they fitted into the sections which lighting changes were unclear. By having a scientist walk on stage, pull an imaginary lever or push an imaginary button, this cued the lighting to change and forced the particles to move on to the next section of the piece.

The intention of this piece was to educate the audience on a science topic in an unconventional manner. This was also meant to inspire those to seeking solutions in unexpected areas such as how the choreographer sought out answers to physics with dance.

The Choreographic Process of "Equal but Opposite"

As this project was collaborative, the choreographers decided to create and perform a piece together. This decision applies beautifully to the scientific concept of a duet about equal but opposite charges, since the choreographers are equals in the context of this project. Often, science classes utilize practice problems with equal but opposite charges in regards to a magnet placed in an electrical field. The choreographers then decided to utilize a bench to represent the bar magnet, and act as the charges themselves.

In the beginning part of the process, the focus was inspired solely by the phrase, "equal, but opposite." Examples of such exploration are up versus down, reaching out versus in, utilization of arms or legs, and dancing on the bench versus dancing on the floor.
When the movement quality had persisted to the point of monotony, the choreographers decided to step away from the bench to create a movement phrase that varied in speed and accent quality, but did not apply to the piece itself. In a different rehearsal, this phrase was then adapted to take place on the bench and reflect the concepts of the piece. At this time, the decision was made to incorporate positive (+) and negative (-) motifs through the use of arms and extensions.

Repulsion became the next theme to consider. While experimenting with ideas of repulsion, ways to incorporate the theme into previously set movement became apparent. A particular moment where this occurred was when the charges first attached to the magnet; their hands came close to touching before sliding off the bench. They realized this was a point where they could change the accent of the movement to depict repulsion. Towards the end of the piece, the concept was extended to not only affect the charges, but the relationship between the charges and the magnet.

In the ending of the piece, images such as the one below and inspired the replication of magnetic field lines as our pathway around the bench.

As the ending progressed, the charges became further away from the bench and the magnetic pull from the bench decreased. Proportionally, the pace at which the dancers moved decreased and their energy and connection to the bench, and each other, decreased. Choreographically, this translated into a run, a jog, and finally a walk. The fourth pass resulted in a loss of all connections between any of the elements depicted in the piece. This was highlighted by the fact that the visual connection between the two charges and the bench was completely lost. As the charges passed the opposite poles of the bench during the fourth rotation, three lunges occurred. The choreographers included these lunges as a last minute change to both break the repetition of walking, and also to remind the audience that the pull of the electric field still existed, but was no longer strong enough to pull the charges inward. This resulted in the final moment of the dance, in which the charges continued the pathway offstage.

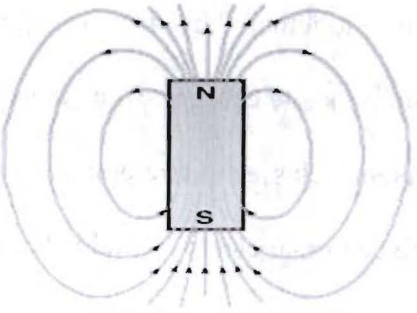


Figure 1

The Choreographic Process of "Propagation"

Last spring, dancers from the Ball State Dance Department Program performed a concert at the Muncie YWCA. The *Kinetic Energy* concert served as a way to carry forth the presence the of the dance program at the YWCA. In response to this plan, "Propagation" was inspired by the idea of continuing a process. As the charitable aspect of the show resulted from a cause that began last semester, the piece was meant to represent cause and effect, specifically through the physics concept of waves.

A unique aspect of "propagation" was that the piece was purposefully choreographed in a very short amount of time. Though it is often more comforting to come to rehearsal with a plan and set choreography, the challenge behind "Propagation" was to find a more natural resolution to ideas than one could pre-plan. Instead of the choreography being planned, the only pre-planning that occurred in the choreography process was deciding the strategy for setting movement. The dance was purposefully choreographed in only three rehearsals instead of a semester's worth of rehearsals so there was no temptation to over analyze the choreography or stray from the challenge.

The movement creation process began with two dancers selecting movement phrases from choreographer improvisation. A third dancer was then added to the dance, forming new movement from the combination of the first two waves. The new dancer began her wave by following the first dancer's floor work movement with a slight delay, and after following the whole phrase, began following the standing dancer's phrase. When the third dancer had followed both phrases independently, she incorporated elements of both phrases to create a new phrase.

After creating all three phrases, the choreography could be manipulated using the equation $V=f\lambda$, with velocity (V) being the speed of the movement, frequency (f) being the

number of repetitions, and wavelength (λ) being movement size. Continuing the principle of cause and effect, the manipulation of one factor in the equation causes the change in another factor. For instance, if the dancers were to increase their movement size, or wavelength, they would subsequently need to increase their speed as well. In the beginning of the dance, the equation strategy was primarily used to manipulate speed and frequency, so the dancers either repeated their phrases twice at double time, or execute only half of the combination at half time.

Following a series of velocity and wave equation manipulations, the choreographic inspiration came from natural resolution to previous movement choices. An example of this is when a dancer fell backwards into the arms of another dancer and was spun around. When the dancer landed, her natural response was to fall forward off her balance. In response to this, the dancer was allowed to fall forward, and a third dancer was ready to provide her feet as a rebound platform. Reactive choices such as this were made throughout the dance. Instead of pre-planning movement, the choreographic process allowed for the dancers to find movement's natural resolution, and continue this process till the end of the piece, like a ripple in a pond continues outwards till the waves eventually dissipate.

As the dance continued, there came a moment when a backbend used at the beginning of the piece naturally recurred. This connection to the beginning phrases allowed for an opportunity to further explore connections to the equation $V=f\lambda$. The dancers were asked, again, to manipulate their phrase using the wave equation, this time concentrating on wavelength as the independent factor. One of the dancers was then selected to indicate the time this process would end, and at this point she reconnected to her fellow dancers. This new section started with a ripple, beginning with the dancer who initiated the change, so the other two dancers would have time to resolve what they were dancing before entering the ripple.

Even though the choreography was selected specifically for its natural flow, the movement eventually became habitual and began to look placed and stiff on the dancers. The dance was choreographed in a short amount of time so the movement would maintain its freshness, but even in a short three rehearsals, it is common for dancers to build habits in movement that distract from the original or natural intent, and this piece was no exception. In areas where the choreography looked forced, there was a need for the dancers to review the reason for the movement. In one particular situation, all three dancers were holding hands and the middle dancer fell forward with her left foot in coupé. Her natural resolution to this was to pull forward slightly on her left side, pulling the dancer on her left into the motion. The choreographic choice from that natural reaction was for the falling dancer to pull the dancer to her left to wrap all the way around the group. The decision worked beautifully the first attempt, but as practice continued, the dancers began to anticipate the lift and the dancer who was supposed to be pulled began initiating the partner work and running around the group instead. The solution was to retrace the steps, and remind the dancers of the origin of the movement. Once the original intent was rediscovered and contemplated, the dancers appeared more natural in their movement.

One of the purposes of "Propagation" was for the dancers to have freedom in their movement. Dancers often feel pressure to not make a mistake in performing the choreography, but since responding organically to movement requires one to make allowances for adjustments, the dancers were told there were no mistakes in the piece, only "changes," to the choreography. Those changes were not only acceptable, but encouraged if there was any motivational change in the movement.

It often feels abnormal to work in conditions where the choreography is open to interpretation, especially when the choreographic process itself is completely open-ended. It is not a process that works for all choreographers, but it is a challenging process that is worth the discomfort, because it can create awareness of how naturally movement can flow.

The Choreographic Process of "Star Stuff"

"Star Stuff" was a late addition to *Kinetic Energy*'s line up. Its inception occurred when Erika, the choreographer, was searching for preshow music. One "rabbit trail" led to another and Neil DeGrasse Tyson's interview with TIME magazine set to piano music was found. His words were an instant inspiration. He spoke of connectivity to one another as well as to the Universe itself. This fit into the theme of wanting to display every action has a reaction in the show by means of donating the proceeds to the Muncie YWCA. Therefore, it was important to include a piece such as "Star Stuff" in order to represent the show's connectivity to the community and to express to an audience the importance of realizing that connection to each other.

Choreographing to spoken words for some is quite challenging as it is easy to become literal in one's approach. However, "Star Stuff" posed no problem for the choreographer as the sudden strike of inspiration flowed easily from mind to body. Simple movements and gestures were used to supplement Neil's words rather than overshadow them. The motif of the hand held out from the elbow, to the side of the body came from the idea of displaying. This form of displaying is similar to that of the way Vanna White presents the completed phrase on the game show Wheel of Fortune. The dancer (the participant) is displaying the question for those to see. As the process continued, the same motif was altered by the participant adding "invisible" ingredients to the question. For example, the participant reaches into the sky, grabs a part of the Universe and adds it to her hand. The universe is now part of the answer to the question. She then adds herself into the motif, and even looked back into her hand in disbelief that she was part of the answer. Finally, the decision was made to include her heart as part of the answer. Her heart represents the fact that she is alive and added together with herself and the Universe resulted in the answer Neil gave the TIME reporter. While this piece was a late addition to the

show and was choreographed quickly, the purpose and meaning behind it impacted the show greatly.

The Choreographic Process of "Open Me Up"

The heart is the physiological driver of everything we do; it pumps the oxygen rich blood to all of our bodies' tissues, responding accordingly with the demands we place upon it. The purpose of "Open Me Up," was to serve as an artistic response of worship to the creator of the complex cardiac machinery. The challenge of this piece is to even partially capture the complexity of the heart. Since the heart does contain many components that function simultaneously; a large group of dancers was necessary to demonstrate the complexity, and full beauty, of the heart. A formal auditions process resulted in a group of eight female dancers.

A unique aspect of "Open Me Up" was that the music was written specifically for the dance. Working in collaboration with the composer, Andy Enochs, allowed for the music to be reflective of the introductory music and of the overall concept of the piece. Dialogue with the composer allowed for clarification of choreographic ideas and resulted in music that was innately reflective of the dance's message. Ideas were passed back and forth between the two artists until there was a cohesive clarity in the ideas the piece was to represent and the music.
Instead of beginning with the music written by Andy Enochs, the piece began with "Kaleidoscope Heart" by Sara Bareilles, and a sound clip of an infant's heartbeat. "Kaleidoscope Heart" was selected for the lyric, "I have hope that inside is not a heart, but a kaleidoscope." This lyric was insightful to the idea that the heart is both a necessary bodily organ for survival, and also an item that is more complex than comprehensible. Incorporating the song created an opportunity to view a human as a whole, and their reflection on their heart, before diving into the heart itself. In addition, the song provided a style and tone for the composer to continue in his work, which allowed for continuity in the overall sound of the piece.

As the dance began with a solo, it was important to choreograph with the skills of the soloist in mind. The choreography needed to reflect the individual discovering the complex cardiovascular system inside her, but the solo was also an opportunity to showcase the extension and control of the soloist. The choreography from this solo would serve as a source of motifs to carry on throughout the entirety of the dance. An impactful lesson from choreography class emphasized the need to continue themes throughout a work to give it continuity and assure that the piece carrying the same story line. Movements such as the dancers tracing veins on their arms recurred many times as a reminder of the connection between an individual as a whole and their internal workings. Other connections to the solo served a similar purpose; to remind the audience of the big picture.

When it came to solidifying the conceptual content of the dance, the process began with detailed research and an annotated bibliography, and continued with a personal explanation of the heart's "story." The story could then be simplified into a condensed sequence of events, which drove the sequence of choreography. The condensed sequence is as follows:

> Heart beats as whole→ autonomic electrical impulse establishes normal heart rate→ blood is pumped through body in a specific pathway→ blood is oxygenated and deoxygenated as it flows from the lungs to body tissues→ 02 is loaded on hemoglobin molecules for transport→ parasympathetic system slows down heart rate→ sympathetic system speeds up heart rate to increase cardiac output.

Breaking down the story of the heart into segments allowed for an easy way to break down the choreography process into pieces. Each step of the physiological sequence of the heart

required its own rehearsal, and since the timing of some sections were indistinct before they were set on the actual dancers, this process allowed for a more efficient planning and rehearsals in the long run. Because troubleshooting of one section could take place before the next section began, it allowed for the next section to have an accurate starting point, making choreography much easier to place musically. Each rehearsal ran with this strategy, starting with review of old material, teaching of new material, and cleaning of new material if time allowed. The teaching component of rehearsal often involved experimentation and editing of original choreography, depending on how the choreography transferred from a mental image to an actual group. It is difficult to change a phrase that took a long time to choreograph, but it is often necessary to create movement that looks organic on the dancers.

Choreographing eight dancers was a difficult process, because a natural quality does not always occur in all the dancers at the same moments. For example, some dancers grasped the fast, intense section of the dance quite naturally, while others have naturally softer movement and found the new intensity unnatural. For the dancers in "Open Me Up," the choreography was made for the majority, and then the group worked together as a whole to find a unified feel for the choreography. This may have changed the original intent at times, but it made the dancing look more clean and purposeful overall.

In regards the individual sections of choreography, various processes were used to teach the dancers and set their choreography. In the beginning ripple section, for instance, there were moments where each individual dancer was given the choice of how to execute the two extensions and how to travel from the ground to standing. After evaluating the dancers' choices, one version of the combination was selected from each ripple group so there were different versions represented, but the ripple looked clean overall from the uniformity within each

individual ripple. In a later part of the dance, the choreographic process was different due to space limitations. In this section, the goal was to represent oxygen binding to hemoglobin through a turn and lift series across the floor. Because the space was instrumental in determining timing the choreography could be contemplated and roughly planned, but not solidified until it was set on the dancers in the performance space.

When the entire piece was choreographed, the next step in the process was to try variations of movements and clean the choreography so concepts could be clearly portrayed. Dancers are artists, so each dancer interpreted the choreography in a different way, which can make choreography appear chaotic. The most effective way to respond to this predicament is to break down choreography and clarify expectations of details such as arm angles, intensity, and even utilization of breath. As an example, the ending section of "Open Me Up" represented the sympathetic nervous system stimulation and therefore incorporated faster movements than earlier in the piece. This section in particular had the potential to communicate something sharp and strong, but was messy when the dancers first learned it. Even so, after slowing down and clarifying each movement dancers were able to concentrate on and match the nuances of the challenging sequence.

Choreographing a piece of work inspired by science concept can be complicated and daunting, because there is a bigger concept to represent and a pressure to hold true to that concept. The beauty of the work, however; comes when the art accurately portrays the science in a way that is beautiful to an audience, whether or not they follow the science behind it. It is as if the audience has an innate understanding of a larger concept, and the art that is created is a complex and wonderful piece, because it is searching for knowledge, beauty, and wonder all at the same time.

Artistic Explanation of "Researchin'"

The scientific process is taught to even the youngest of students in elementary school: Ask, Research, Hypothesize, Experiment, Analyze, Repeat (Science Made Simple). These steps are explored in "Researchin'" with the first step being "how can we turn on one foot?"

The piece opens with one scientist proposing an idea to another. The latter rejects the idea which causes the first to think of the problem. She is able to elaborate her idea by observing others and gaining inspiration from them. The scientists then begin their research and the "L" arm motif, which is done in preparation for a pirouette (a turn on one foot), begins to appear in the piece. Observation is key in this piece as can be seen when the five scientists look into the night sky for inspiration. Once they find the inspiration, it becomes an idea which leads them on different pathways.

Another important part of the scientific process is encountering failure and these scientists do that quite a bit throughout. It is important to note that none of the scientists are deterred from their failure, but continue forward with their work. The more important aspect of the scientific method that many do not know is present throughout the whole process is collaboration. The five scientists interact in the piece by sharing ideas, handing over previous work, and observing each other's experiments. Not one person in the piece discovers the pirouette, but collectively they discover the findings together. A celebration ensues and the work is then shared with the "scientific" community and now everyone has the ability to perform a pirouette. Finally the scientists are done and ready for their next experiment, and set the stage for the next piece, "Ideal."

Artistic Explanation of "Ideal"

This "experiment" is a representation of the Ideal Gas Law. This particular law explains the relationship that occurs in Nobel gases between temperature, pressure, and volume. The law itself states PV=nRT where P is pressure, V is volume, n is the number of moles (particles), T is temperature, and R is the gas constant (8.314 joules per mole per degree Kelvin). Under this law, the three varying factors (pressure, temperature, and volume) are completely dependent upon the number of moles rather than the type of gas is present inside the volume (Nave).

At its heart, "Ideal" is a chance dance. The movement is done within extremely specified rules that coordinate with the law: temperature is the speed of the movement, pressure is the quality of the movement, and volume is represented by the area marked out by lighting. The particles then enter and exit various sizes of volumes with various amounts of other particles which determine the way they move.

Within the piece, there are only five movement combinations. Some particles take longer to execute the movement while others take a shorter amount of time. The most obvious display of this occurs in the ending with three separate and equal volumes. One volume has three particles, then two, and then one. They all start the movement at the same time, but the volume of the three finishes first, repeating the ending movement over and over at top speed. The volume of one is the slowest to finish and determines when everyone moves onto the next phrase. This thus depicts a volume with more particles has a higher energy, which is noted in terms of temperature, and a volume with fewer particles has less energy, or is colder. The quality of movement is also noted most obviously in this last phrase. The volume of three manipulates the movement so that it is sharper and accented. These three particles are also seen colliding with each other. This is compared to the volume of one where her movement is fluid and wide as she

is not colliding with anyone. This depicts the relationship pressure has to the number of particles within a specific volume. Thus, with a higher number of particles, there is higher pressure. By assigning dance qualities to the equation, this piece was created through simple manipulations with the purpose of educating on the relation between the values of pressure, volume, and temperature.

Artistic Explanation of "Equal but Opposite"

"Equal but Opposite" begins with scientists carrying a bench, which represents a bar magnet, on to the stage. Two charges, dressed in black and white, run on stage and attach themselves on the opposite side of the bench in a plank. From this point, fluid movement carries the charges on and around the magnet. As they move, the charges execute movement that contrasts each other. While one charge moves vertically, the other moves horizontally, and while one moved up, the other moved down. Each action depicted by the charges represents an equal but opposite quality. The depiction of the charges in relation to the magnet is not so much an explanation of a magnet, as a projection of magnetic concepts as art.

The initial theme used to artistically represent equal but opposite charges is the theme of opposition, which evolves into repulsion, and finishes with the pathway of electromagnetic lines. In regards to the theme of opposition, the most obvious example occurs early in the piece, when the white charge is on all four limbs on the bench, and the black charge is lying flat on her stomach on the ground. Their hands are placed in the same region of the bench and they extend horizontally from there in opposite directions. The white charge then presses her hips away from the center as the black charge pulls her feet toward the center of the bench, representing opposites in the form of push and pull.

The evolution of the repulsion concept is well represented when two the two charges are pulled into the center together, and then are forcefully separated. The dancers reach towards one another, pressing against the air as if against a pane of glass. Their chests are first attracted towards the center of the bench, and then collapse backward as if being forced away from each other. The dancers once again pull in, this time closer, and then are pushed backwards with a stronger force, so both are standing on opposite sides of the bench. Though the idea of two

charges repulsing each other represents a new concept, it is also a continuation of the equal but opposite concept, as the force repelling the charges is equally placed on each charge, but they are forced in the opposite direction.

The end of the piece becomes a representation of the direction of the charges, not just away from each other, but also in their magnetic field pathways. To represent magnetic fields, the charges move around the bench in half circles, moving farther out from the bench to represent the magnetic field that is further away from the bar magnet. As the charges move further away from the bench, their decreased pull to the magnet is demonstrated by their decreased velocity and eye contact with each other.

Though the demonstrated behaviors of charges on a magnet actually occur at the same time, the various behaviors are broken down into multiple elements so each element can be artistically interpreted separately, allowing for increased movement vocabulary and a deeper understanding of the scientific principles.

Artistic Explanation of "Propagation"

The inspiration from "propagation" comes from the idea of action and reaction. This concept ties into the ideas of ripples and waves, which are the scientific inspiration for the piece. Every choreographic decision in the dance ties into the idea of a natural resolution or reaction to events, previous choreography, or ideas. The piece begins with movement phrases that were chosen by two of the dancers from watching their choreographer improvise to the music. The dancer's choices not only reflected the choreographer's natural reaction to the music and concepts of the piece, but also their own reaction to those elements.

A third dancer's interaction in the movement involves the concept of wave interference (Norton). After being exclusively affected by one dancer's groundwork wave, the dancer in the middle is also affected by the standing wave that comes in. As in wave interference, the elements of the two independent waves come together in this section to form a new wave, or choreographic phrase.

Purposeful decisions were also made to manipulate and select movement, and these decisions served as the start of a chain of natural reactions. The first manipulation that occurs is the arrangement of the original movement phrases to match changes in the equation $V=f\lambda$ ("The Wave Equation"), where velocity is the speed of the movement, frequency is the number of repetitions, and wavelength is the size of the movement. The changes in the dancers' choreography at the beginning of the piece directly relate to this equation. For instance, if a dancer were to increase the repetitions of their phrase, they would need to increase the speed so the equation remained balanced.

Manipulations in the middle of the piece primarily from the choreographer decided what would be a natural way of continuation from the previous movement to the new movement. The

decisions at this point were made not to fit a concept or math problem, but to be consistent with the direction the choreography seemed to be going. For instance, when one dancer was lifted, it was her natural inclination to lean backwards upon her landing. The choreographer decided a fall backward was the most natural way to continue, so the dancer fell backwards and spiraled down into a sitting position. The choreographic decisions that are seen thus far are decisions on how to handle moments such as those. This process of decision-making and cause and effect inspired movement continues well into the piece.

Towards the end of the dance, the dancers again use the equation $V=f\lambda$, this time manipulating the size of their movement and how it relates to speed. One wave particle, for instance, repeats her original battement but in smaller, and subsequently slower, manner.

The ending of "propagation" is another continuation of the idea of action and reaction as well as the idea of natural resolution. The action in reaction, combined with choreographer's choice, comes into play as dancers create an additive ripple of turns that references an earlier moment in the piece. From there, the dancers grab towards the floor and turn outward from each other. The dancers then begin reaching towards the floor with the eventual goal of ending on their stomachs, limbs spread. Each dancer reaches this goal in their own natural way without restrictions on the timing. The piece begins with a resolution of the choreographer's improvisation, and eventually ends with another resolution of the dancer's choice.

Artistic Explanation of "Star Stuff"

> *Interviewer:* What is the most astounding fact you can share with us about the Universe?
> *Neil DeGrasse Tyson:* The most astounding fact…
> *I:* The most astounding fact.
> *NDT:*…is the knowledge that the atoms that comprise life on Earth, the atoms that make up the human body, are traceable to the crucibles that cooked light elements into heavy elements in their core under extreme temperatures and pressures. These stars, the high mass ones among them, went unstable in their later years. They collapsed and then exploded scattering their enriched guts across the galaxy. Guts made of carbon, nitrogen, oxygen and all the fundamental ingredients of life itself. These ingredients become part of gas clouds that condense, collapse, form the next generation of solar systems, stars with orbiting planets, and those planets now have the ingredients for life itself. So that when I look up at the night sky and I know that yes, we are part of this universe, we are in this universe, but perhaps more important than both of those facts is that the Universe is in us. When I reflect on that fact, I look up – many people feel small because they're small and the Universe is big – but I feel big, because my atoms came from those stars. There's a level of connectivity. That's really what you want in life, you want to feel connected, you want to feel relevant you want to feel like a participant in the goings on of activities and events around you. That's precisely what we are, just by being alive.

A scientist walks on stage to finish her experiment on wave propagation. As she walks back, she begins to take off her lab coat signaling her journey back home. The question "what is the most astounding fact" is asked as she walks back on. She herself is pondering the question, as her hand is now held out to the side. She turns around and the question is asked again, as if it's sitting on her palm for all to see. She turns a third time, and now begins to answer the question.

The simple representation of the word "knowledge" by the participant placing one hand in another exemplifies the necessity of communication and connectivity. She goes on to display the process in which stars go under as they mature until their fuel runs out and they explode. By

the participant exploding herself and peeling off the ingredients (carbon, oxygen, nitrogen) from her forearms foreshadows the simple, astounding fact that "we are in this Universe and the Universe is in us." This answer is not meant to be daunting, but rather, is meant to be joyful. This is seen by the participant, smiling, as she gathers her body's atoms, looks up into the sky, and sees the connection between herself and the expansive universe. "That's what you really want in life," Neil says, "you want to be connected." Here, as the participant looks up into the night sky is where the audience realizes this isn't one person, but the participant is all of us. And thus the answer, the final answer, is done by the participant placing her hand over her heart, and then returning to the original position whence the question is first asked. By doing so, the participant is saying our beating heart, the mere fact we are alive in this place, is the most astounding fact.

Artistic Explanation of "Open Me Up"

"Open Me Up" begins with a solo, which represents an individual's introspection into her own physiology. Throughout the solo, the dancer looks down at her chest and arms as if her skin is made of glass and she can peer inside to see her own heart and veins (Wilmore 127). On the lyric, "I have hope inside is not a heart," she is lifted above the group and on, "but a kaleidoscope," she is dropped into the group of dancers and becomes part of the heart; the kaleidoscope.

After the solo is finished, each dancer becomes an equally important part of the heart. The group portion of the dance starts with a ripple that depicts the electrical impulse that travels through the heart and causes it to contract. If the group's formation created the anatomical arrangement of the heart, the ripple begins at the location of sinoatrial node at the bottom left corner of the right atrium, continues to the atrioventricular node, down the ventricular septum of the heart, and to the outside outer edges to cause a contraction (Wilmore 127-128). The order of the ripple is initiated based on this pattern, which the impulse travels in the heart.

As the electrical impulse leads to the proper functioning of the heart, the electrical impulse section of the dance leads into a section that explains the cardiac cycle (Pathway). The group of dancers is split into three sections here; one group in the middle to represent the heart, one in the back to represent the lungs, and one in the front to represent the body being moved by oxygen rich blood. In the heart group, the center dancer represents the filling and emptying of the heart by opening up her arms, contracting, and then releasing the dancers into either the pulmonary circulation or systemic circulation of the body (How the Heart works). The dancer on stage right then travels to the pulmonary circulation, or lung circulation, to be given oxygen. The dancer on stage left travels to the body so the oxygen rich blood can be utilized to initiate

movement. The function of the pulmonary circulation group is to take deoxygenated blood and give it oxygen, which the choreography represents through lifts, giving a visual representation of physically giving breath to the deoxygenated dancer. The group representing the systemic circulation begins in the opposite manner. The dancers entering the pulmonary circulation have oxygen, which allows them to move the dancer who has already given her theoretical oxygen to the systemic circulation. After a dancer acts as the mover and gives up their oxygen to the body, they need to be moved by the next dancer leaving the lungs, then return to the heart to start the cycle over again (Wilmore 154).

To highlight the idea of oxygenation and deoxygenation, the next section of the dance uses contrasting standing and floor work. Because oxygen is needed by the body to create energy, the standing group represents blood that contains oxygen, while the lower energy ground group represents blood without oxygen. At the end of the section, all dancers turn until off stage, the oxygenated group performing a high chaîné, and the deoxygenated group rolling on the ground.

To dive deeper into the process of oxygenation, the next movement becomes a depiction of oxygen binding to hemoglobin, which is the mechanism most oxygen uses to travel in the blood (Wilmore 151). Here, the dancer representing oxygen and the dancer representing hemoglobin dance around each other first to represent free floating molecules, then the oxygen dancer wraps herself around the hemoglobin dancer in a spinning lift to represent the binding process. The process is further demonstrated when the oxygen dancer is wandering next to the hemoglobin dancer, soon joining in the hemoglobin's choreography and beginning more partner work to represent binding.

Up to this point, the process of the heart that is depicted is representative of a normal heart rhythm. When the music slows down and decreases intensity in the next section, however, the movement follows the music to demonstrate what happens when the parasympathetic nervous system slows down the heart rate (Wilmore 130). At this point, the dancers complete a phrase all together at a moderate speed, and then incrementally begin repeating the phrase more slowly, till finally all the dancers are moving much slower than the original phrase. The incremental changes in tempi are again initiated through a ripple following the electrical impulse pathway. The same ripple then reverses into a section of choreography initiated primarily by the chest, which then leads into another music change, and a depiction of sympathetic nervous stimulation.

The sympathetic nervous system causes the heart rate to increase in order to match the demands placed on the body (Wilmore 130). In this section of the dance, the soloist is brought forth again and performs a series of heart rate raising movements such as jumps and leaps. The dancers behind her are moving more quickly than any other part of the dance to demonstrate what is happening to the heart inside the soloist. While this is happening, some connections in choreography are made between the soloist and the dancers representing her heart rate. One example is that the dancers step back and form an "x" shape while the soloist performs a leap in second position, emulating the movement of the dancers behind her.

Both the fast section of the choreography and the high intensity movements of the soloist end with the dancers tracing the veins of their arms and perform a flexed battement to the front. The heart dancers then begin circling around the soloist, and the soloist slowly moves backwards to the middle of the group. The image here is that the circulation happening inside the soloist is visible to her, as she examines her heart and veins, and visible to the audience as they watch the

dancers encircle her. The soloist then expands her arms and places her right hand on her chest to feel her heartbeat, and at this point, the dancers that represent the heart shrink back in a line behind the soloist, becoming a part of her as an individual. The soloist then feels for the heartbeat that she just raised, and ends the piece beating her chest to its rhythm. The dance has come full circle; the individual has realized her place in a larger idea, and has also realized how the larger idea fits inside her.

Erika Ripley's Rehearsal Notes

Rehearsal Times

"Ideal"- Saturdays from 4-6pm

"Researchin'" – Fridays from 7-9pm

"Equal, But Opposite" – Wednesdays from 1-3pm

"Star Stuff" – Various weekends depending on soloist

Journal Entries

The following journal entries are from Erika Ripley's personal rehearsal process. Listed in chronological order, the entries' purpose range from the beginning brainstorming done in the Spring 2012 semester to corrections given the day before the show. Not all ideas that were created in the brainstorming portion were used in the final product of *Kinetic Energy* due to time constraints, as well as collaborative editing with Hannah Smalley. Erika's choreographic process and notes occurred during the rehearsal times more so than in outside prep-time. There are only a few instances within the entries that movement was created outside of rehearsals, without dancers present. The majority of the entries are in fact corrections that were scribbled while the choreographer watched her dancers during rehearsal time. These corrections were then given to the dancers, crossed off from the journal, and thus the piece moved towards a clean, finished product.

Once the pieces were finished choreographically, Erika placed her outside rehearsal time on the production of the show. Therefore another large portion of the entries includes lighting, transitions, various show titles the two choreographers developed, and rough program notes.

"Ideal" was incredibly lighting heavy and therefore was cleanly mapped out for the lighting designer to easily interpret. While the journaling process may not look like an organized process, each choreographer works best by using their own creative organized system.

Honors Project

"Continuous Motion"

Continuous show, no pausing

- [illegible] only science
- Portal 2
- The universe autotune
- What Pi sounds like
- Tau "
- Golden Ratio Music

$PV = nRT$

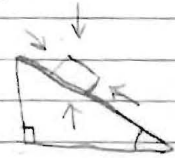
"ΣF"

"The Sum of all Forces"

Adagio for Tom

Duet plus people props

Strong dude + itty bitty girl



build triangle "wedge"

box = strong dude

The force we act on one another as well as ourselves

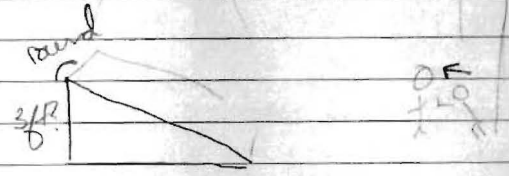
$F = F_g + F_v + \ldots$ $F = ma$

∴ What pulls us down
What pushes us up
What stops us dead

Big Fat Emotional piece
↑ Similar mood to choreo final

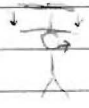
Flows from PV = nRT into this
↑ particles push to wing IB has to push away

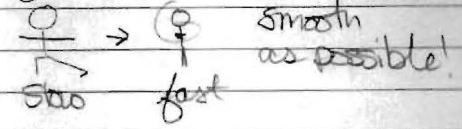
Snowball effect, tiny things that pile up

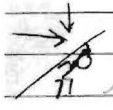


Angular momentum

lifts

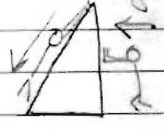






ride 1st part leads to drop off

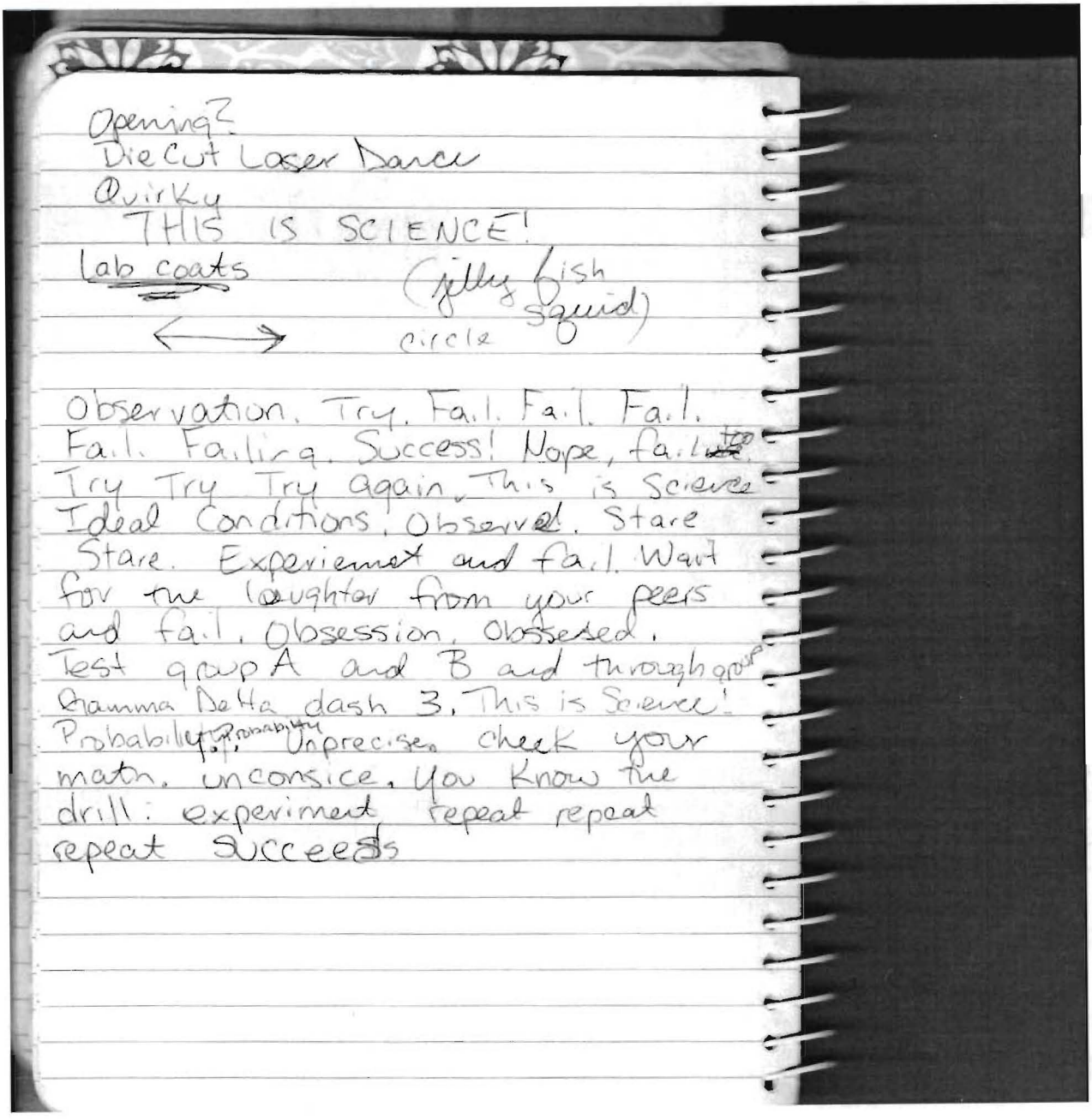
Move Triangle?



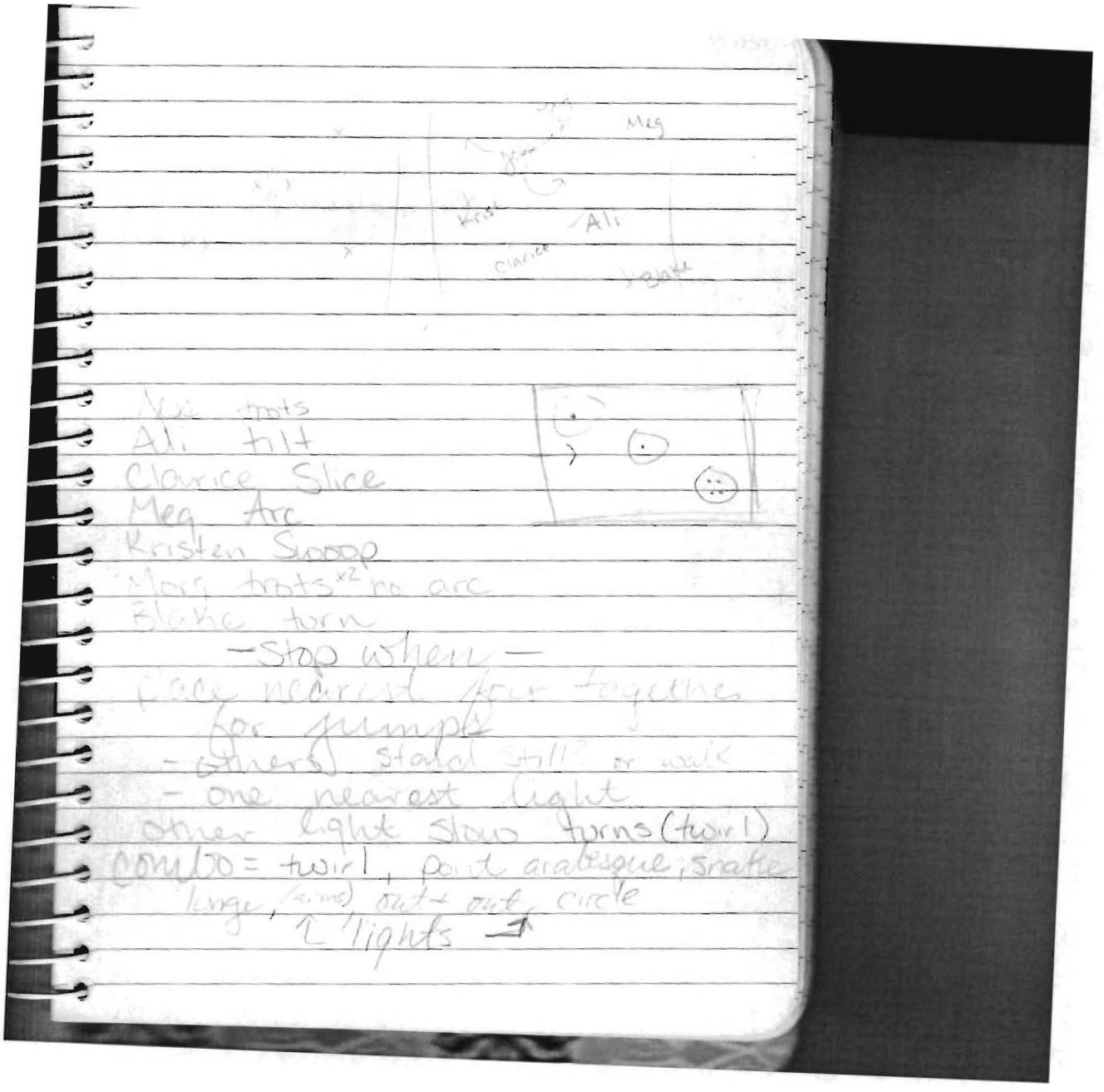
Song: Light through the Veins
by Insides
End credits of Series of Unfortunate

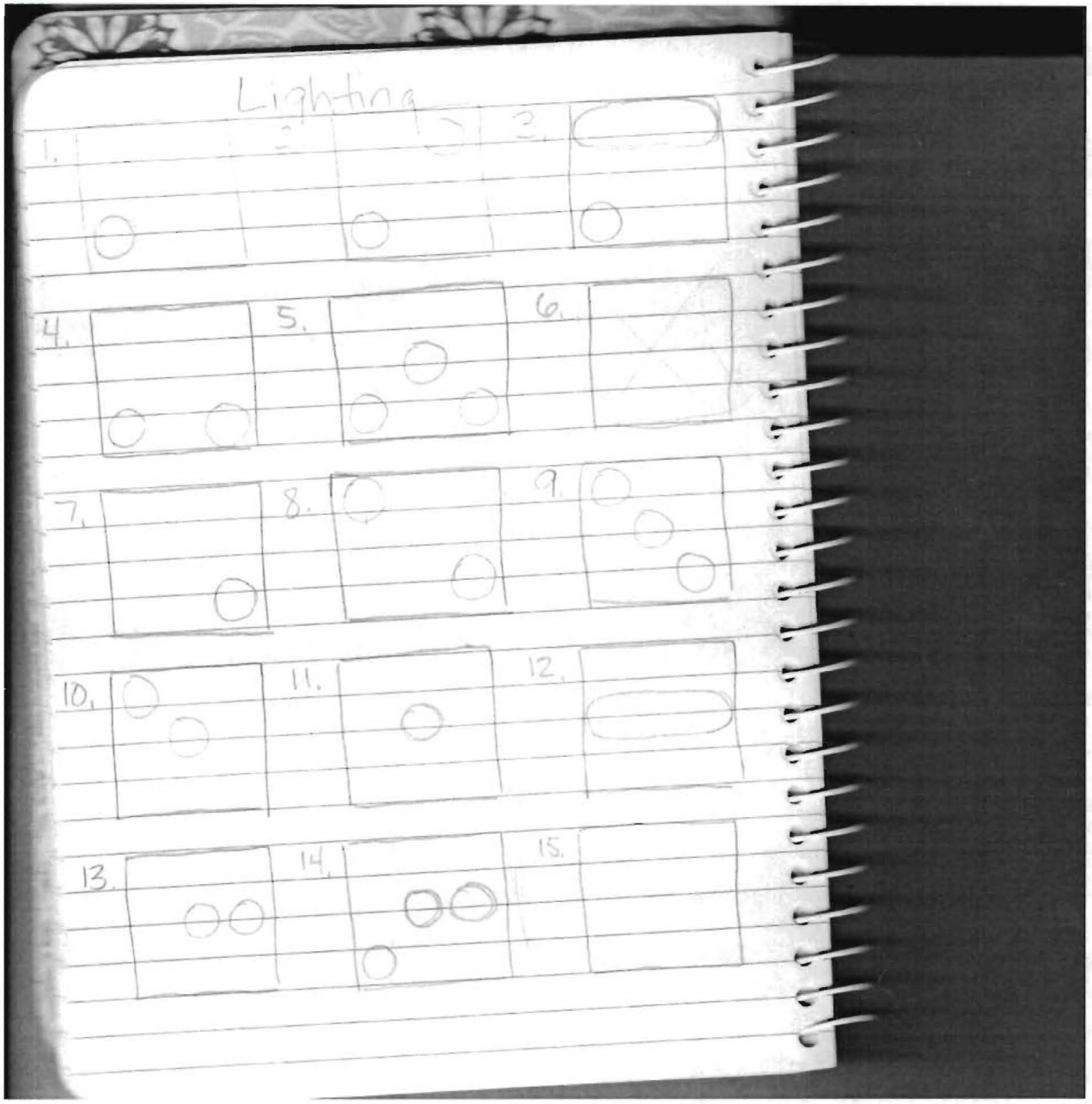
"PVnRT"
"Ideal"

Songs
Armory = single vs triple/double
I made it all up
Halls of Science 4
Bring your daughter to work day


Opening?
Die Cut Laser Dance
Quirky
THIS IS SCIENCE!
lab coats (jelly fish squid)
<--> circle

Observation. Try. Fail. Fail. Fail. Fail. Failing. Success! Nope, fail. Try Try Try again. This is Science Ideal Conditions. Observe. Stare Stare. Experiment and fail. Wait for the laughter from your peers and fail. Obsession. Obsessed. Test group A and B and through group Gamma Delta dash 3. This is Science! Probability. Probability Unprecise. Check your math. unconsice. You know the drill: experiment repeat repeat repeat Success


Meg
Kristen
Ali
Clarice
Blake
Ali trots
Ali tilt
Clarice Slice
Meg Arc
Kristen Swoop
Marg trots x2 no arc
Blake turn
-Stop when-
face nearest four together
for jumps
- others stand still or walk
- one nearest light
other light slow turns (twirl)
COMBO = twirl, point arabesque, snake
lunge, (arms) out + out, circle
↑ lights →


Lighting
1.
2.
3.
4.
5.
6.
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8.
9.
10.
11.
12.
13.
14.
15.

Researching
aura Straight on
arrie mine
ork on jellyfish !*
am Laura same jump
aura more defined movement *
am join seahorses
am faster on slaps
ok at finger

umber Five
alk on to Carrie then think walk
f after jumps go to back curtain,
llie during think, walk to sam,
lly off back cornor thing
~~some~~ think, looks circle, something
front right, do creep w/ hailey
ng to turn, front right snakes

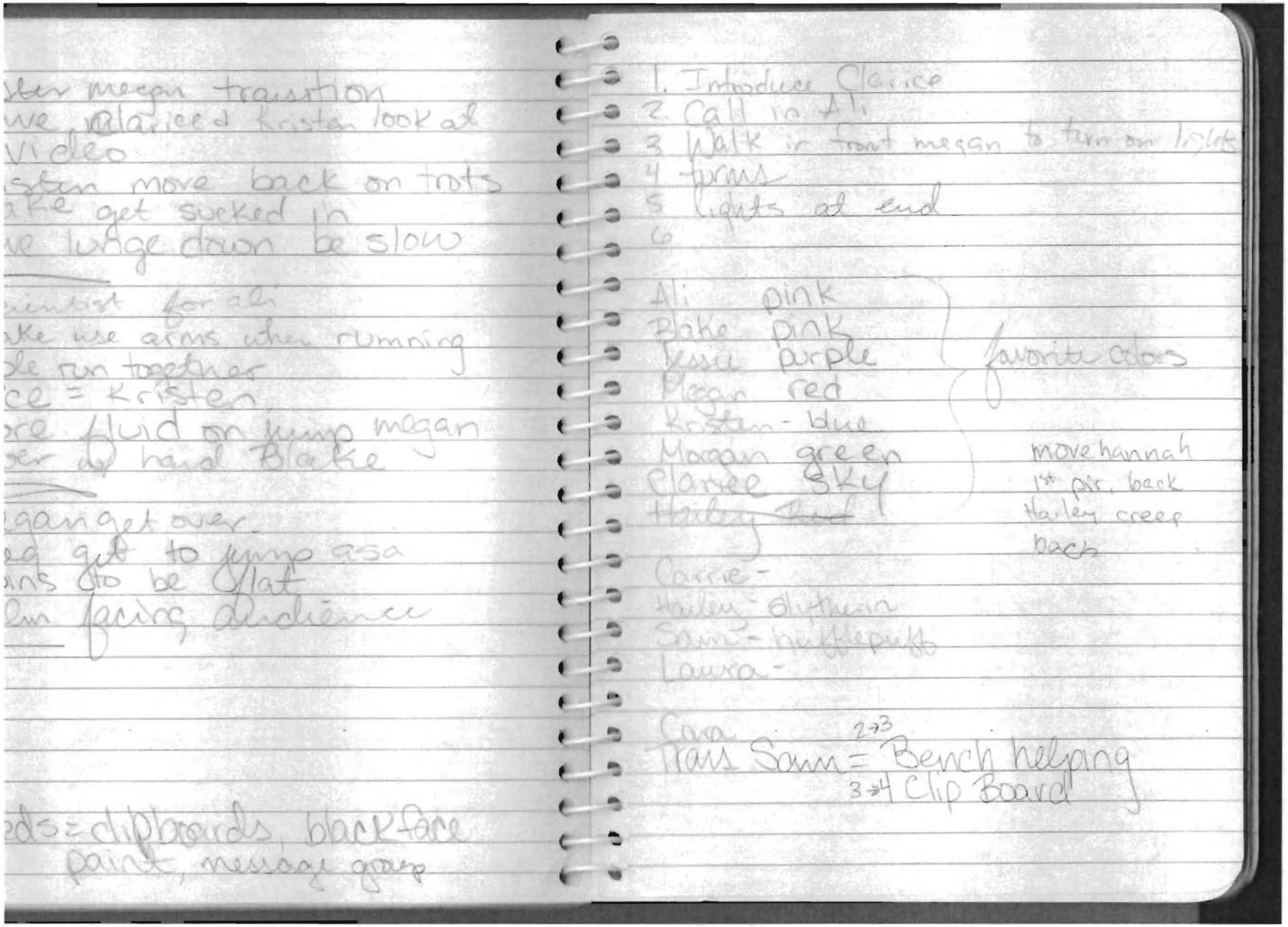
oint, kick, circle fourth jump
round stepstepstep to nose diagonal
oss leg go off center walk around
oke self in eyes step toss arabesque
outine into jumps

Laura first attempt
arms jelly
hit pose before jump

Ideal
~~ask Ali bout practicum~~
Megan Run, others run out
Kristen more flowy
define leg

BAM
Ali get sucked out
Jessie go behind Ali
tighten on turns

Ali let Blake go by
Blake get sucked in



ster megan trasition
we balanced kristen look at
video
sten move back on toes
ke get sucked in
e lunge down be slow

inist for ali
ke use arms when running
le run together
ce = kristen
re fluid on jump megan
er w hand Blake

gain get over
g get to jump asa
ns to be flat
lm facing audience

ds = clipboards, black face
paint, message group

1. Introduce Clarice
2. Call in Ali
3. Walk in front megan to turn on lights
4. turns
5. lights at end
6.

Ali pink
Blake pink
Jessi purple
Megan red
Kristen - blue
Morgan green
Clarice sky
~~Hailey Teal~~

favorite colors

move hannah 1st pir. back hailey creep back

Carrie -
Hailey - Elythera
Sam - butterpuffs
Laura -

Cara
Trans Sam = 2→3 Bench helping
3→4 Clip Board

Researchin'

↓

Ideal $PV = nRT$

↓

Equal, but opposite

↓

Waves

↓

Star Stuff

↓

Heart

Action

REACTION

Equation

Movement = Science

Art = Science

Cara = photo

$\sum_{n=0} [Art] = (Science)(Body)^2$

Kaylin Klein

Program

odd

"Ideal"

$PV = nRT$

Where n = number of dancers (moles)

$R = 8.3145$ J/molK

P = quality of movement

V = lighting

T = speed of movement

Chor

Designer

Particles

"Researchin'"

def - to search or search again we fail and fail and fail and fail and get the solution may be just right there.

Chor

Designer

Scientists

"Equal, but Opposite"

two equal, but opposite charges are placed on the x axis, The positive charge is placed at to the left of the origin & the negative charge is place to the right, as shown in the figure above...

Qnor

Drs

Charges

"Waves"

"Star Stuff"

"The nitrogen in our DNA, the calcium in our teeth, the iron in our blood the carbon in our apple pies were made in the interiors of collapsing stars. We are made of Star Stuff"

- Carl Sagan, Cosmos

Cus

Des

Participant:

"Heart"

The Store
- Clipboards
- Measuring Tape
- Ball point needle

Transitions
1→2 Carrie pulls switch, button madness
→3 Have Sam watch for timing (when lights go) pull on bench slowly! Don't leave corner til dancers are gone. Measure bench take notes on clip board
→4 Sam direct placements of waves, take bench back
→5 Cara w/ lab coat come on take notes w/ clipboard, go off slowly while taking off lab coat to be put in wings
→6 Hailey take Cara's pulse, sends Cara off, takes Steph's pulse

Notes
Kristen reach outside sphere
Megan be closer to Jessica
Hands on hips
Breathe after turns
Kristen stuff at end

Hannah Smalley

Lighting + Stuff
Spotlight beginning + end downstage
starry night move to reds

BUY CLIPBOARDS
STEAL TAPEMEASURE
CONFIRM CAMERA
Decorate gifts
PRINT PROGRAMS

Photos from Tech Week Rehearsal

Figure 1: "Researchin'." The scientist in the middle is preparing for an experiment while the others observe.

Figure 2: "Researchin'." The five scientists look to the sky for inspiration.

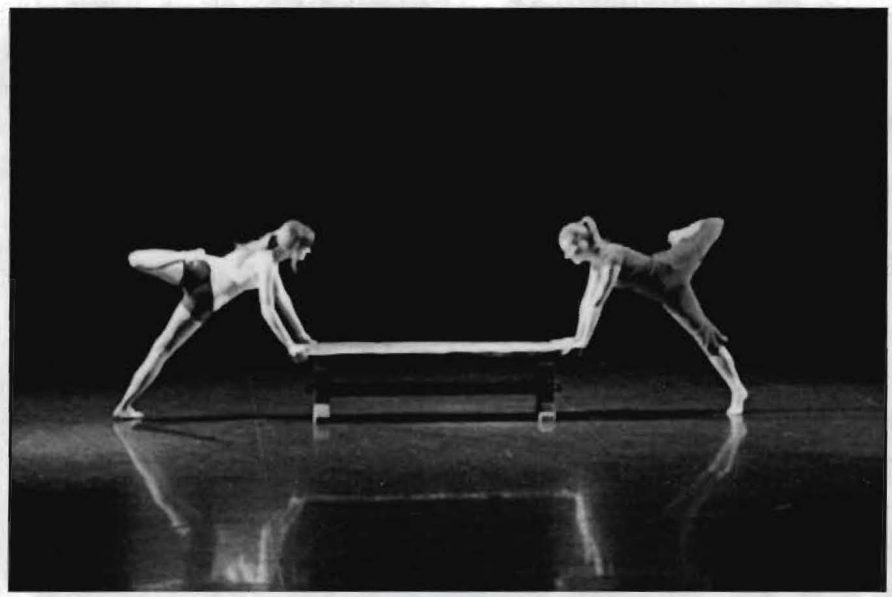


Figure 3: "Equal But Opposite." The charges are being drawn in opposite directions along the magnetic field lines, represented by the reaching of the dancers' legs to opposite sides of the floor.

Figure 4: "Equal But Opposite." The charges attract then repulse each other.

Figure 5: "Propagation." Movement is first initiated in the dancer's core then propagated through all four of their limbs.

Figure 6: "Propagation." Movement waves from the dancers at the far right (standing) and far left (ground) combine to form a new movement wave in the middle dancer.

Figure 7: "Star Stuff." The participant peels off the ingredient nitrogen from her body.

Figure 8: "Open Me Up." The soloist is being lifted before dropping down to become part of the heart she visualizes inside herself.

Figure 9: "Open Me Up." The binding of oxygen to hemoglobin is represented through partner work.

Figure 10: "Open Me Up." The soloist dances intensely as the dancers behind her move quickly to reflect the soloists rising heart rate.

Program

DVD of the Performance

Poster

Annotated Bibliography

Listed in Show Order, Followed by Chronology

Show Inspiration

Bohannon, John. "Dance vs. Powerpoint: A Modest Proposal." *TED talks.* N. p. N. d. Web.

This modest proposal that John Bohannon makes in his TED talk is what I used to describe my idea for using dance as a medium of theory. He speaks of how the humanities and the sciences influence each other and that it is a link that we as a society tend to forget about. He actively displays and persuasively urges members of the science community to use dancers instead of a powerpoint. Within his arguments he claims that the audience will be closer connected with what data is being examined through use of dancers rather than a bar graph. This interaction is what Hannah and I wish to explore with this thesis project.

"Researchin'"

Research. Definition. "to search or to search again." Dictionary.com

Research. Definition. "careful, systematic study and investigation in some field of knowledge."Webster's New World Dictionary.

These two definitions combined serve as inspiration for this piece about research. The words "again," "systematic" and "investigation" were used as the foundation for my movement within this piece. Scientific research often involves following curiosity in order to prove theorems. I heavily used this as the inspiration for my dancers' characters. Their movement vocabulary is quite quirky and somewhat absurd, yet within both fields of science and art, it is those who stretch outside the boundaries (and sometimes ridiculed for their effort) who succeed.

"Understanding and Using the Scientific Method" *Science Made Simple.* Science Made Simple, Inc. 2006-2001. Web. 13 Dec. 2012.

This site provides the basic form of the scientific method that most people know today with a brief explanation of each step. This information was used as a base line for initial choreography and tone, but further research was done in order to expand on these simple steps.

"The Real Process of Science" *Berkely University.* The University of California Museum of Paleontology, Berkeley, and the Regents of the University of California. 2012. Web. 13 Dec. 2012.

This webpage from Berkeley University provides the answer to a more updated scientific method. It was this method that was used during the choreographic process of "Researchin'." By having a more detailed description of the processes and the various pathways one can take to reach a conclusion, it was made easier on the choreographer to create new ideas to represent science. The page also includes specific examples of what happens during each step which was used to create movement motifs throughout the piece.

The choreographer's personal experience within lab and science courses has been the major impact on this piece. The scientific method ends not with "conclusion" but with "repeat." It is the fact that scientists within the research field will do the same thing over and over, making minute changes, failing to produce their goal for years. Working collaboratively towards a goal enhances the effort of success, which was translated that into this piece as the five dancers work together to inspire each other.

"Ideal"

Nave, C.R. "Ideal Gas Law." *Georgia State University.* 2012. Web. 13 Dec. 2012.

This basic site provides the definition and explanation of the Ideal Gas Law. It also goes into depth on each aspect of the equation for those who have never taken a physics course. The basic definition and representation of the variables was used in the program to explain the piece to audience members. The variables were taken from the equation and manipulated to fit a dance.

Young, Hugh D., et al. *University Physics with Modern Physics.* 12th Ed. Print.

This textbook was used in Ball State's Physics 120 and 122 courses. It was during this class the choreographer was inspired to apply physics concepts almost literally to dance. During the specific lecture on the Ideal Gas Law was the moment when the choreographer first created the idea to use dancers as a representation of particles. Whilst performing practice problems from this textbook, it reinforced the idea could be successful visually through the use of dancers. All knowledge gained from the textbook as well as the two courses it supplemented, were used as inspiration for "Ideal" as well as the project itself.

"Equal, But Opposite"

Nave, C.R. "Bar Magnets." *Georgia State University.* 2012. Web. 13 Dec. 2012.

Graphics were used from this website as inspiration for pathways and movement during the choreographic process of "Equal, But Opposite." In addition the explanations used on this site were translated by the choreographers to dance terminology and movement structures.

"Star Stuff"

Reader Submission. *Ten Questions for Neil DeGrasse Tyson.* TIME Magazine. 26 June 2008. Web.

One specific question stood out from this interview: "What is the most astounding fact you can tell us about the Universe." Neil's following answer provided the visualization and inspiration for the piece "Star Stuff." His words were paired with a piano piece, enhancing the deep meaning in his words. This alone was the only research needed for the choreographer as the average audience member did not need to know how the Universe is structured or exactly how a star undergoes fusion to understand his answer.

Sagan, Carl, dir. *Cosmos.* British Broadcasting Company. 1980. Film.

Carl Sagan, a prominent astrophysicist says within this film "The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of star stuff." This quote was meant to go hand in hand as the simpler version of Neil DeGrasse Tyson's interview. The choice to include this was also influenced by the need to show an audience the potential scientists they themselves could look up and find inspiration from as the choreographer did.

"Propagation"

"The Wave Equation." *The Physics Classroom.* N.p., n.d. Web. 13 Nov. 2012.

This site gave me the "equation" inspiration for the piece; Speed=Wavelength/Frequency, or V=f. I would use this to manipulate repetitions in my piece so if I increased the repetitions of the movement, but left the size of the movement (representing wavelength), then I would

increase the speed with the repetitions. If I wanted to keep the speed, on the other hand, I would have to decrease the size of the movement to keep the equation balanced.

Norton, John D. "The Quantum Theory of Waves and Particles." *Einstein for Everyone*. Department of History and Philosophy of Science: University of Pittsburgh, n.d. Web. 13 Nov. 2012.

Though this site provides a great deal of information about waves and how they work. To keep the idea of simplicity in the piece I will primarily use the diagram on the site that explains the superimposition of matter waves. Conceptually, I want to use this concept by adding movement patterns of two other people together to form a completely new movement pattern.

"Open Me Up"

"3D Medical Animation - Congestive Heart Failure." *YouTube*. Biodigitalsystems, 20 Sept. 2010. Web. 20 Aug. 2012.

This video is useful because it shows the pumping motion of the heart. It is important to note from this video the internal opening of the bicuspid valve in conjunction with the pumping of the ventricles. It is also significant that the left side of the heart pumps slightly harder than the right ventricle, due to the more difficult task required of it to pump blood through the systemic circulation. Because of the required work, the left side of the heart is visibly thicker.

"How the Heart Works."

YouTube. VisibleBody, 06 July 2010. Web. 20 Aug. 2012.

This video shows the filling and emptying of the ventricles in the heart. I plan to use this video imagery when I depict the cardiac cycle.

"Pathway of Blood through the Pulmonary and Systemic Circuits." *Digital image.Phschool.com.* Pearson Education Inc., n.d. Web. 21 Aug. 2012.

This image shows the pathway that the blood takes through the heart. The pathway graphic is laid out in a manner that would be easy to set up a representation of the flow through the dancers' pathways. I also plan to depict each specific section of this cardiac cycle (the lungs oxygen to blood, the heart recieving blood from the lungs and pumping it through the body, and the oxygenated blood allowing the body to function) and the continuous flow of blood that occurs in the cycle through coordinated group work.

"Hemoglobin." *Hemoglobin.* N.p., n.d. Web. 16 Sept. 2012. <http://gassama.myweb.uga.edu/>.

This website is useful because it has multiple images that depict the action of hemoglobin binding with oxygen, which I plan to depict toward the end of the piece.

Wilmore, Jack H., and David L. Costill. *Physiology of Sport and Exercise.* Champaign, IL: Human Kinetics, 1999. Print.

This textbook has been the subject of study for multiple exercise science classes, and contains the scientific details of the anatomy of the heart and how it functions. This resource will be used to sequence the cardiac events depicted in the dance as well as to provide imagery for choreographic inspiration in its photos and graphs.

Ball State University Presents

KINETIC ENERGY

$(1/2mv^2)$

A Performance Honors Thesis By

Erika Ripley ↴ ↶ Hannah Smalley

7pm
Dec. 8th & 9th, 2012
Ball Gym, KDS 213

$3 for Students
$5 for Adults
All procedes go to YWCA

Explore science and dance as you've never seen it before

Erika Ripley
Kinghorn Hall
Ball State University
Muncie, IN 47306

Dear Erika,

Thank you so much for your contribution of $325.00 for the YWCA of Muncie on behalf of Ball State Dance.

All gifts help implement the programs and services that the YWCA provides for the Muncie and Delaware County area and help maintain and improve the historically valuable 82 year-old building at 310 East Charles Street.

You may use this letter for your tax return preparation. The YWCA of Muncie is a 501(c)3 not-for-profit organization. Since no goods or services were provided to you by the YWCA in consideration of this contribution, the entire amount is tax deductible.

Again, thank you for your generous support. The YWCA of Muncie sincerely appreciates having you among its friends and supporters.

Sincerely,

Nance Buchert

Nance Buchert
Executive Director

Ball State University Presents

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Erika Ripley is extremely excited this project has finally become a reality. Throughout her college experience she has struggled to find the "correct" career path for her that would please her many interests in the arts and sciences. She has bounced from being a dance major to astrophysics to fashion to entrepreneurship. Often, in her physics lecture she would daydream on how to represent the lecture's topic through dance. Oppositely she would find herself applying basic physics to her jazz combinations. Finally, in order to graduate on time she settled with a General Studies major with three minors in performance dance, entrepreneurship, and apparel design. Being a part of the Honors College has always been a pleasure for her as it is the best place at BSU for minds to flourish and for people of many different backgrounds and interests to collaborate. She is truly honored to have worked with such a wonderful people on this project and hopes it will give people the opportunity to see just how connected everything is in this world.

Hannah Smalley is an Exercise Science major with a minor in Dance Performance. Throughout her undergraduate science courses, she was captivated by the complexity and beauty of the concepts she studied, particularly the human body. Her interest in creating this show came from her desire to reflect upon the heart as praise to its designer, and developed into a whole show in collaboration with Erika Ripley. She feels blessed to have the opportunity to work with such talented dancers in a context where she can express what is often seen in black and white in color. Hannah will attend physical therapy school in the fall of 2013, and plans to pursue creative movement throughout her career.

Researchin'

Definition: (v) to search or search again.

We fail and fail and fail and fail and yet the solution may be just right there.

Choreographer = Erika Ripley

Music = "Fireflies" by Gattobus as performed on a TENORI-ON

Lighting = Kaylin Klein

Costuming = Erika Ripley

Scientists = Hailey Higginbotham + Laura Mansur + Carrie McKendree + Samantha Morse + Hannah Smalley

Ideal

A law that describes the relationships between measurable properties of an ideal gas. The law states that $P \times V = n \times (R) \times T$, where P is the quality of movement (smooth vs sharp), V is the lighting, n is the number of dancers, T is the speed of movement, and R is the gas constant (8.314 joules per degree Kelvin). A consequence of this law is that, under constant pressure (P) and temperature (T) conditions, the volume (V) of a gas depends solely on the number of moles of its molecules (n), not on the type of gas.

Choreographer = Erika Ripley

Music = "I Made It All Up" by Aperture Science Psychoacoustics Laboratory

Lighting = Kaylin Klein

Costuming = Erika Ripley

Moles of Molecules = Jessie Baetz + Morgan Baetz + Ali Ball + Kristin Dowdy + Megan Jensen + Blake Markley + Clarice Nolan

Equal, But Opposite

Two equal, but opposite charges are placed on the x axis. The positive charge is placed at the left of the origin and the negative charge is placed to the right, as shown in the figure above...

Choreographer = Erika Ripley + Hannah Smalley

Music = "AIR" by Alone in Kyoto

Lighting = Kaylin Klein

Costuming = Erika Ripley + Hannah Smalley

Charges = Erika Ripley + Hannah Smalley

Propagation

$V=f\lambda$

Where V=speed of the movement, f=frequency of repetition, and λ=size of the movement.

Choreographer = Hannah Smalley in collaboration with the wave particles.

Music = "Ba Ba" by Sigur Rós

Lighting = Kaylin Klein

Costuming = Hannah Smalley

Wave Particles = Michele Mackowiak + Carrie McKendree + Stephanie Metzger

Star Stuff

"The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of star stuff."

-Carl Sagan, Cosmos

Choreographer = Erika Ripley

Narration = TIME Magazine's "10 Questions for Neil Degrasse Tyson"

Music = "To Build a Home" by the Cinematic Orchestra

Lighting = Kaylin Klein

Participant = Cara Calanni

Open Me Up

I have hope that inside is not a heart, but a kaleidoscope.

The Sequence of our Heart Story:

Heart beats as whole→electrical impulse establishes normal heart rate→blood is pumped through the body in a specific pathway→blood is oxygenated and deoxygenated as it flows from the lungs to body tissues→O_2 is loaded on hemoglobin molecules for transport→parasympathetic system slows down heart rate→sympathetic system speeds up heart rate to increase cardiac output

Choreographer = Hannah Smalley

Music = "Kaleidoscope Heart" by Sara Barreilles + an original composition by Andy Enochs

Lighting = Kaylin Klein

Costuming = Hannah Smalley

Cardiac Cells = Hannah Christopher + Heather Closson + Suzanne Foreman + Michele Mackowiak + Laura Mansur + Stephanie Metzger + Taylor Pramuk + Becky Wolfe

Discussion with Choreographers and Advisors

We welcome the audience to stay afterwards to participate and listen to our discussion. This will help to further enhance the understanding of our show and individual pieces. If you are still confused on what you have just witnessed, we welcome you to stay and ask questions. Movement may be performed in slower forms with narration from the choreographer to demonstrate concepts.

Special Thanks To:

The Honors College

Sarah Manglesdorf and Anna Priebe, our Honors advisors.

The Department of Theatre and Dance

Lucas Moore, science consultant.

Andy Enochs, sound guy.

Kaylin Klein, for offering her lighting skills to us.

The YWCA

And finally our parents, for dealing with our array of interests all these years.